The Relationship of Biological Monitoring to Ecological Restoration and Ecological Recovery

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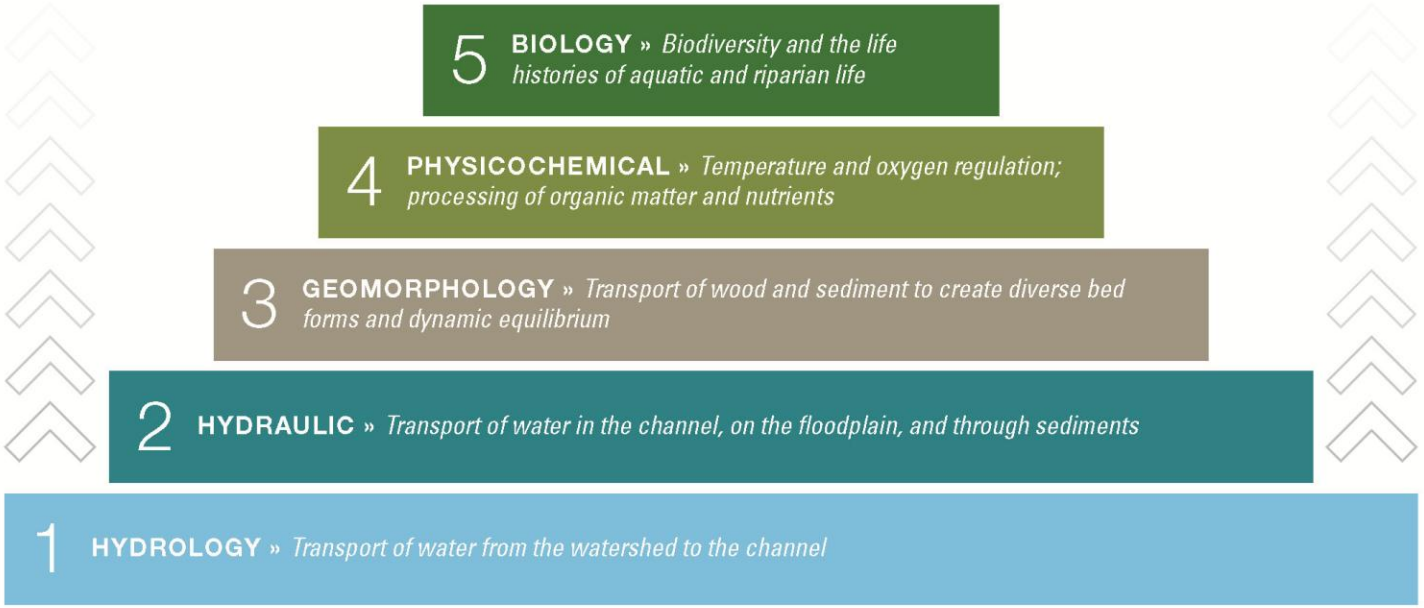
Stream Functions Pyramid

A Guide for Assessing & Restoring Stream Functions » OVERVIEW



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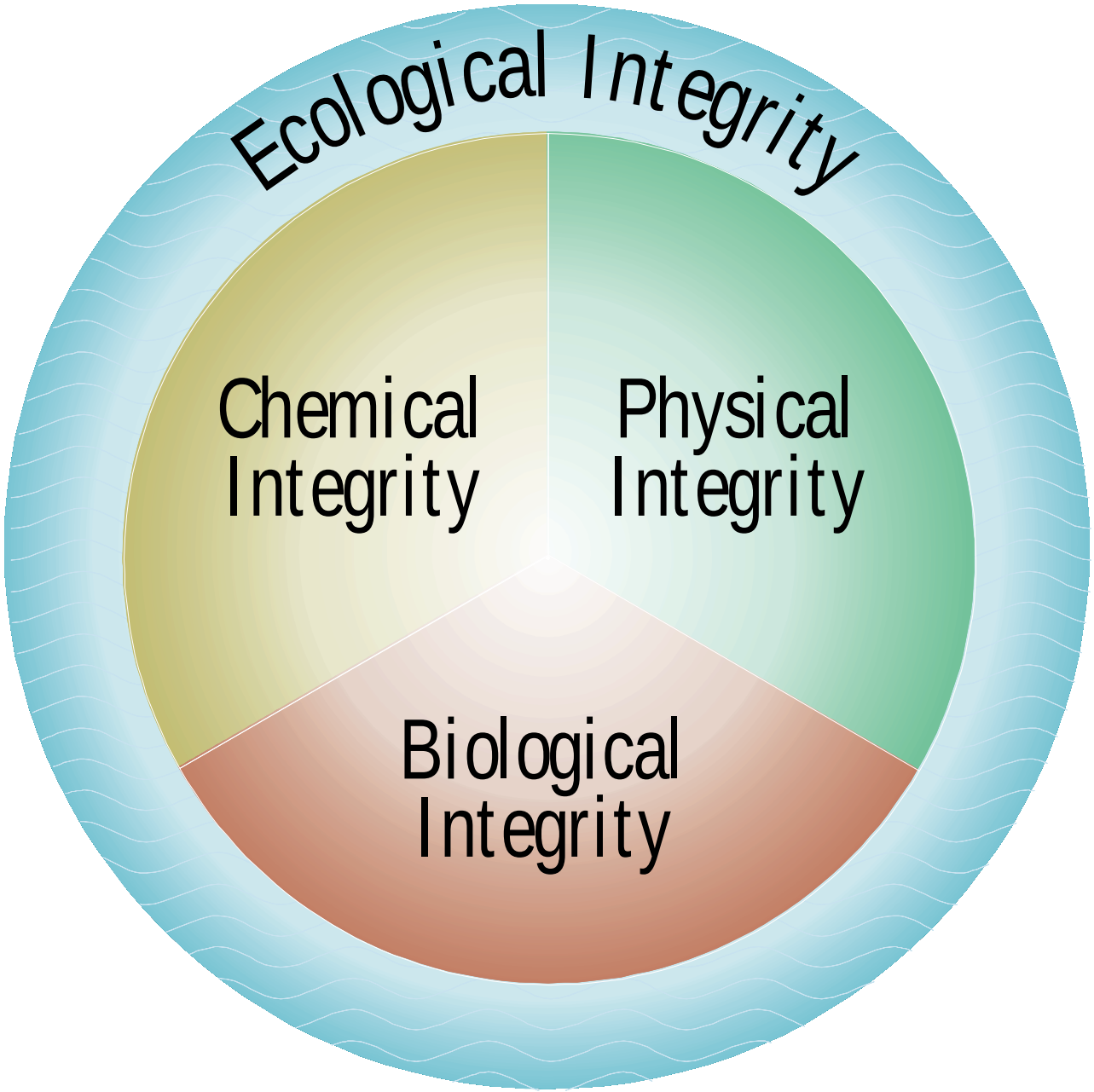
StreamMechanics

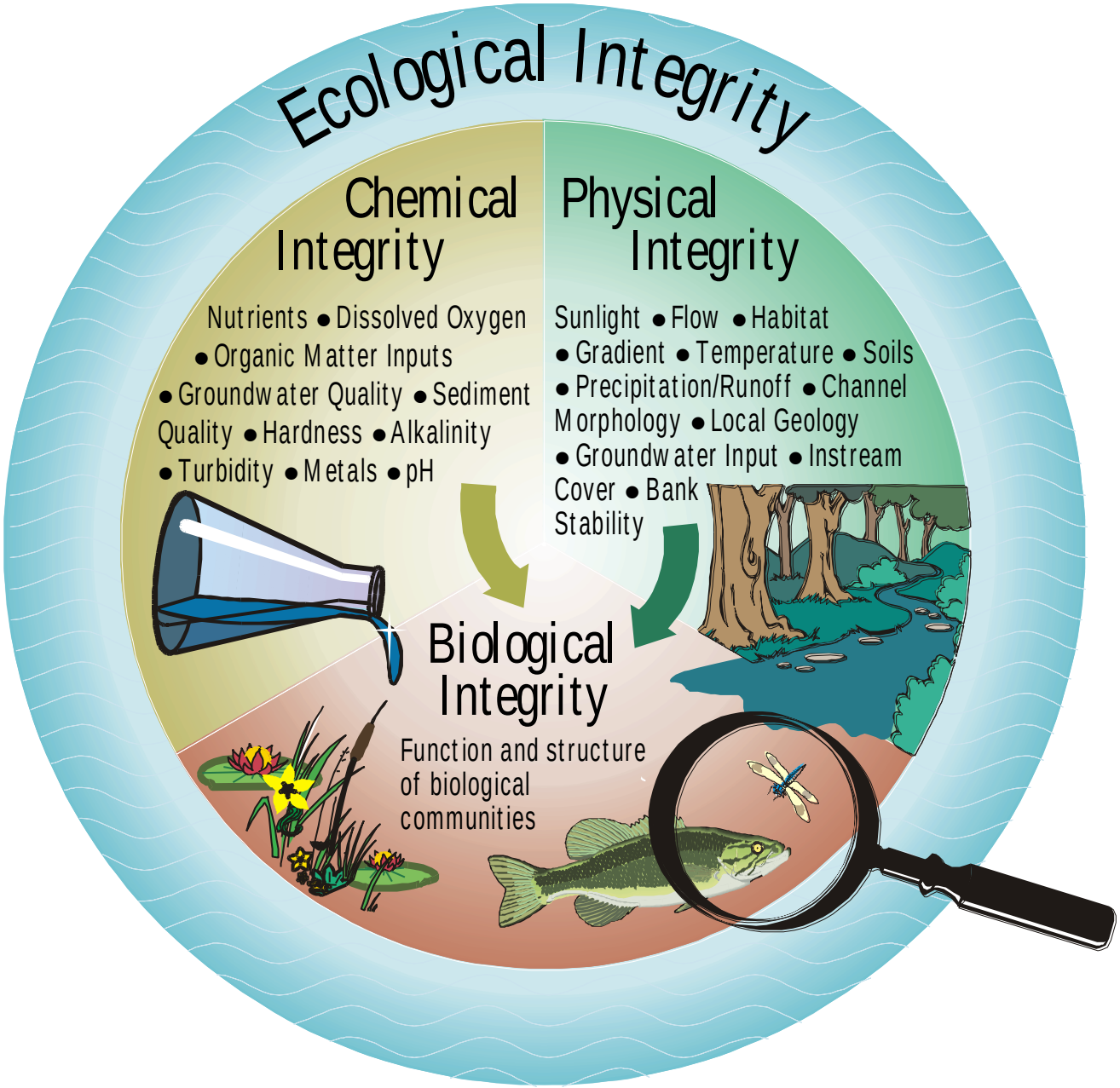
Purpose of presentation

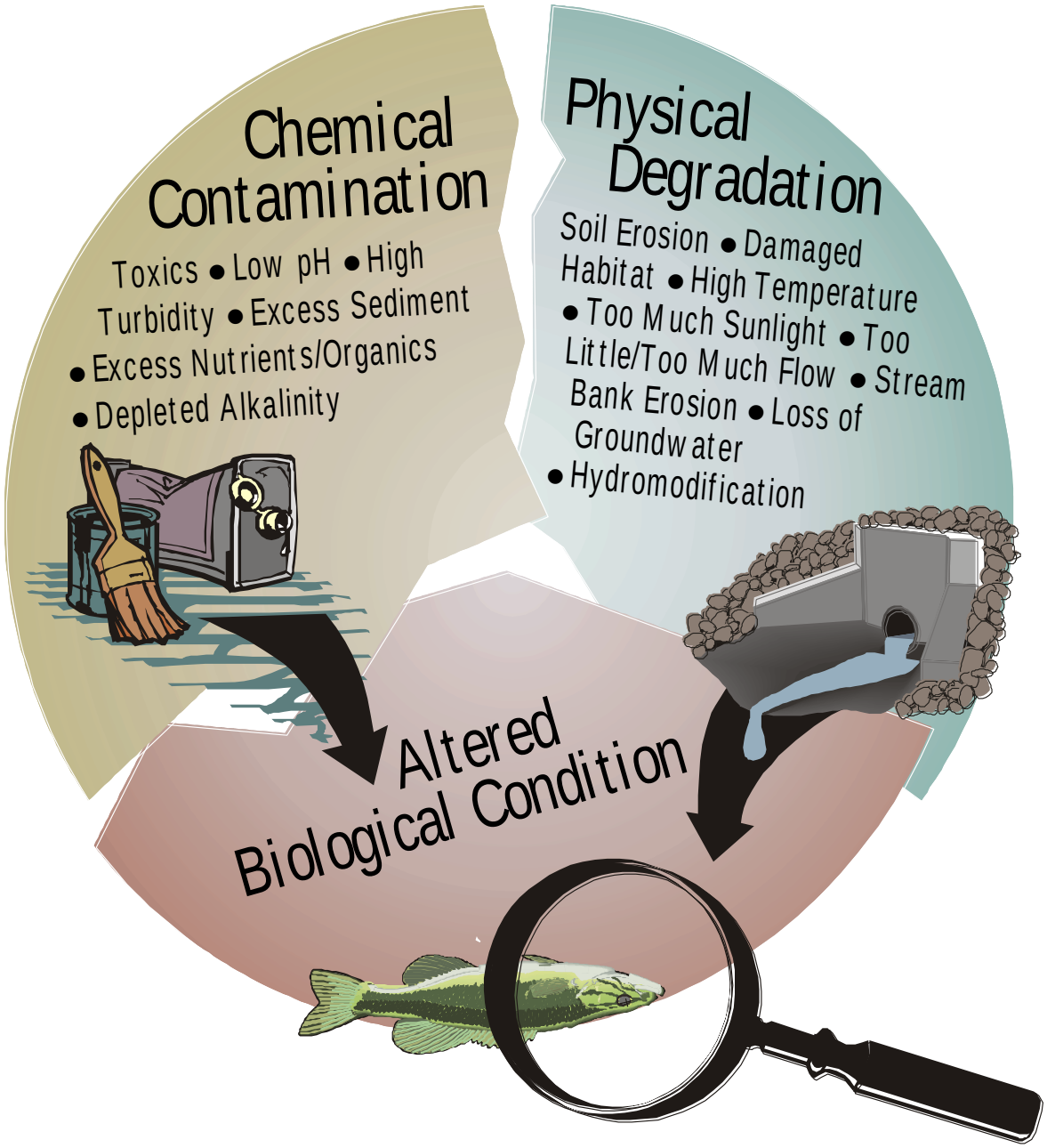
A. What is ecological recovery?
B. Why is it different from ecological restoration?
C. What is biological monitoring and assessment?
D. How are results from monitoring and assessment used for ecological restoration decision-making?

Ecological Restoration ***is re-establishing morphological features of the river or mitigating water quality impediments to represent natural or desired state of being to regain its ability to support a naturally reproducing and sustainable aquatic community relevant to the social, economic and political factors.***

Ecological Recovery ***is re-establishing valued attributes of the aquatic community within a period of time, given its ecological capacity to regain lost functionality, and considering its exposure to stressors affecting its improvement in condition.***

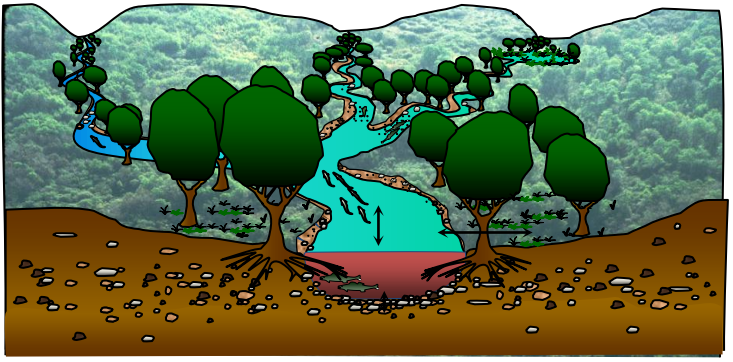

Ecological Integrity
Chemical Integrity
Physical Integrity
Biological Integrity


Ecological Integrity
Chemical Integrity
Nutrients • Dissolved Oxygen • Organic Matter Inputs • Groundwater Quality • Sediment Quality • Hardness • Alkalinity • Turbidity • Metals • pH
Physical Integrity
Sunlight • Flow • Habitat • Gradient • Temperature • Soils • Precipitation/Runoff • Channel Morphology • Local Geology • Groundwater Input • Instream Cover • Bank Stability
Biological Integrity
Function and structure of biological communities


Chemical Contamination
Toxics • Low pH • High Turbidity • Excess Sediment • Excess Nutrients/Organics • Depleted Alkalinity
Physical Degradation
Soil Erosion • Damaged Habitat • High Temperature • Too Much Sunlight • Too Little/Too Much Flow • Stream Bank Erosion • Loss of Groundwater • Hydromodification
Altered Biological Condition

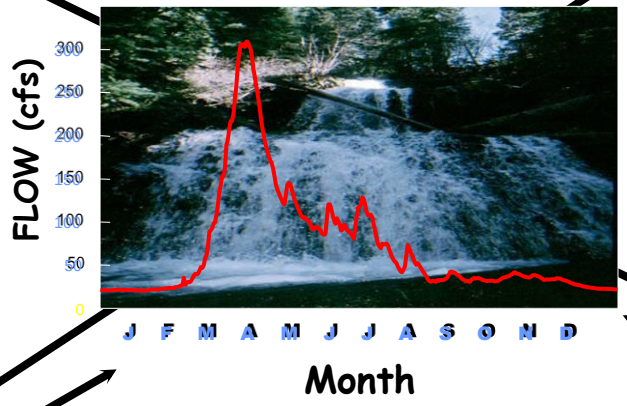
COMPONENTS OF RIVER SYSTEMS

ENERGY
PATHWAYS/CONNECTIVITY



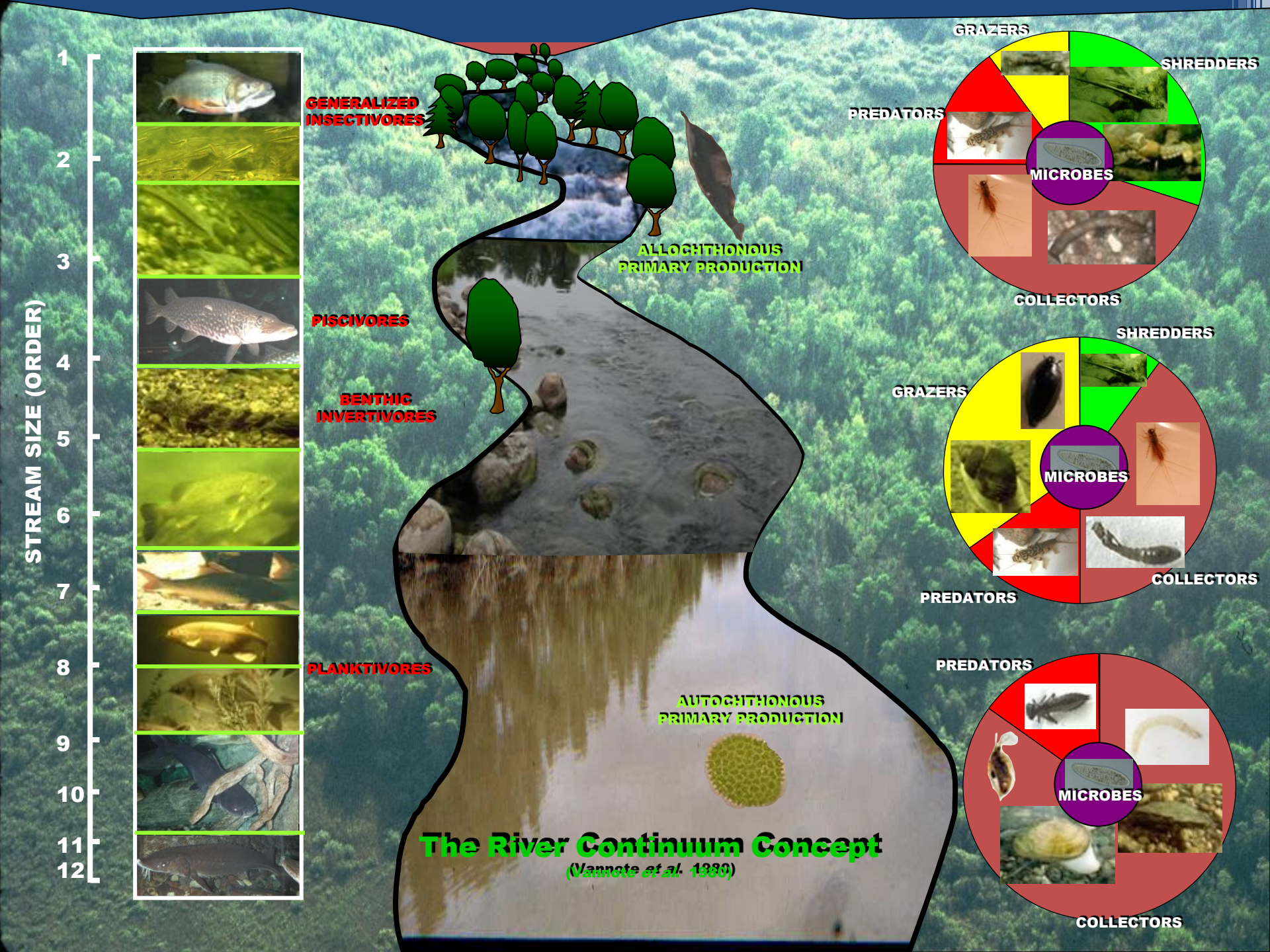
BIOLOGY

HYDROLOGY



GEOMORPHOLOGY

WATER QUALITY


STREAM SIZE (ORDER)
1
2
3
4
5
6
7
8
9
10
11
12
GENERALIZED INSECTIVORES
PISCIVORES
BENTHIC INVERTIVORES
PLANKTIVORES
ALLOCHTHONOUS PRIMARY PRODUCTION
AUTOCHTHONOUS PRIMARY PRODUCTION
GRAZERS
SHREDDERS
PREDATORS
MICROBES
COLLECTORS
SHREDDERS
GRAZERS
MICROBES
COLLECTORS
PREDATORS
PREDATORS
MICROBES
COLLECTORS
The River Continuum Concept
(Vannote et al. 1980)

GOOD

Natural Channel, Diverse

Habitat Structure

POOR

Altered Channel, Uniform

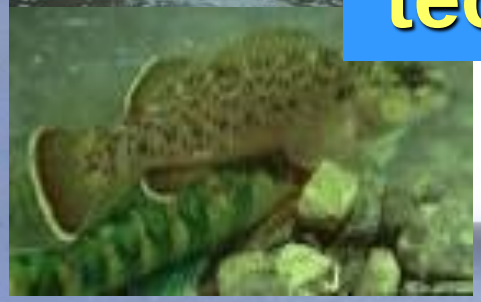
The biota reflect and integrate the aggregate effects of alterations to one or more of these factors.

Comparable to Reference

Chemical Quality

Enriched,

Biocriteria and the attendant chemical/physical tools & indicators provide the technology to measure this.



Native Species Flourish

Biotic Factors

Invasive Aliens Established

The Process

Stressors sources

Stressors

Response indicators

Sources of Stressors

Stressors

Response indicators

Natural “stressors”

These events
are the extreme!

But, they are really
part of the
natural variability…

Sources of Stressors

- Human activities, or the result of human activities, that create stressors

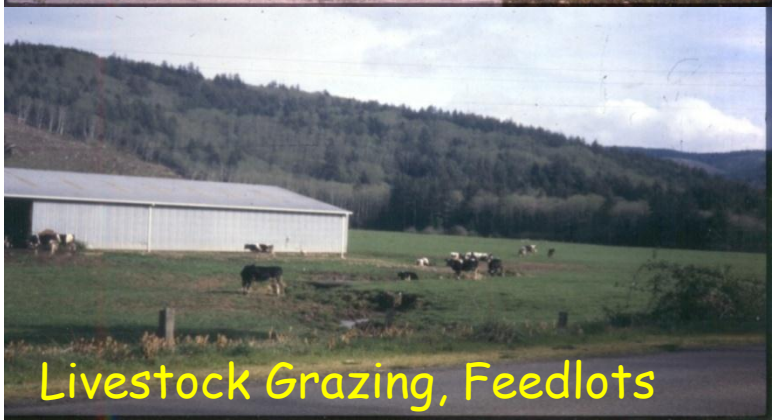
We alter stream habitat in many ways


Urbanization


Logging


Agriculture, Irrigation


Slash Burning, Road Building


Livestock Grazing, Feedlots


Stream "Restoration",
Channel "Maintenance"

- Removal of watershed vegetation
- Urban/suburban development

- **Channel alteration**

- **Urbanization**

The river catches on fire

Cuyahoga River, Cleveland, OH
June 22, 1969

There are many stressor sources

- Human waste/sewage
- Fertilizer application
- Cultural pollutant input
- Industrial effluent
- Hazardous waste site/landfill leachate
- Channel alteration
- Impoundment
- Riparian de-vegetation
- Watershed de-vegetation
- Grazing
- Row crop agriculture
- Transportation corridors
- Surface-mining sites
- Combined animal feeding operations (CAFO)
- Impervious surface/stormwater

Sources of Stressors

Stressors

Response indicators


SEADOO
Stair's #6585
SEADOO


SEA-DOO
Stair's #6585
SEA-DOO
NOTE: Stressed cat

Stressor (biological assessment)

- Any human-induced agent that limits the biological capacity for survival and reproduction

There are many potential stressors

- Metals
- Sediments
- Nutrients
- Ionic strength
- Low dissolved oxygen
- Temperature (degraded habitat)
- Non-native species
- Increased flashiness (Flow alteration)
- Flow hindrance (dams)
- Unspecified toxic chemicals
- Altered energy input (Degraded physical habitat)

Stressors sources

Stressors

Response indicators

Response indicators

- Most widely used in North America, for freshwater ecosystems
  - Benthic macroinvertebrates
  - Fish
  - Periphyton (mostly diatoms)
  - Zooplankton/phytoplankton
- For estuaries
  - Macrobenthos
  - Aquatic vegetation: submerged, emergent, floating
  - Fish

The Biological Condition Gradient: Biological Response to Increasing Levels of Stress

Levels of Biological Condition

Natural structural, functional, and taxonomic integrity is preserved.

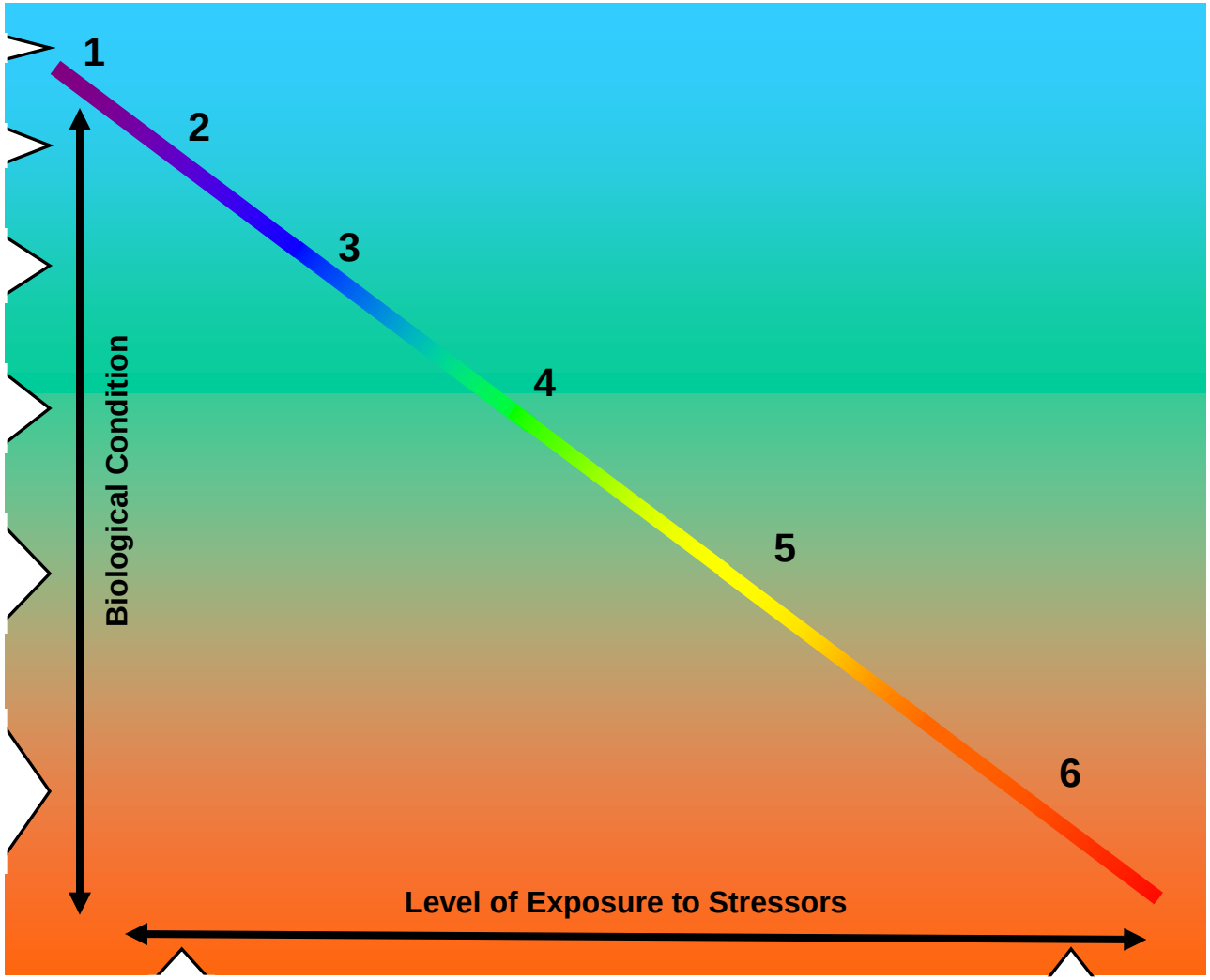
Structure & function similar to natural community with some additional taxa & biomass; ecosystem level functions are fully maintained.

Evident changes in structure due to loss of some rare native taxa; shifts in relative abundance; ecosystem level functions fully maintained.

Moderate changes in structure due to replacement of some sensitive ubiquitous taxa by more tolerant taxa; ecosystem functions largely maintained.

Sensitive taxa markedly diminished; conspicuously unbalanced distribution of major taxonomic groups; ecosystem function shows reduced complexity & redundancy.

Extreme changes in structure and ecosystem function; wholesale changes in taxonomic composition; extreme alterations from normal densities.



Watershed, habitat, flow regime and water chemistry as naturally occurs.

Chemistry, habitat, and/or flow regime severely altered from natural conditions.

生物状态梯度： 对增长的压力层次的生物学反应

生物状况的层次

自然的结构性, 功能性, 和分类的完整性保存下来

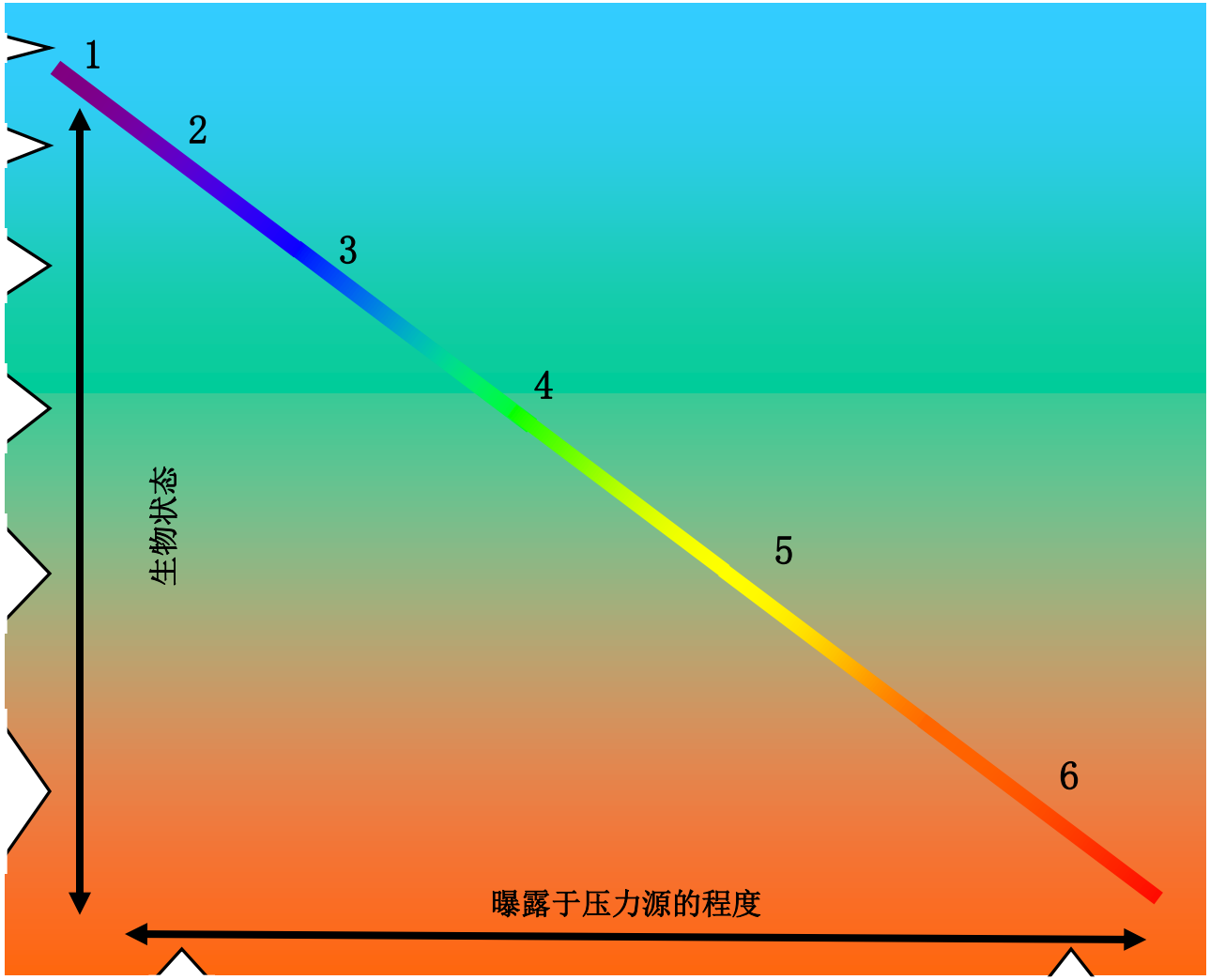
结构与功能和自然群落类似，有某些多出的物种类和生物量，保有全部的生态系统功能

有证据显示结构的变化，少量稀有物种确实，相对丰度发生变化；保有全部的生态系统功能.

中等程度的结构变化，一些常见的敏感种类被更具忍耐性的种类所代替, 保有大部分的生态系统功能.

敏感种大量消失；大多数分类群呈现显著的不平衡的分布；生态系统功能呈现减少的复合性和重复性.

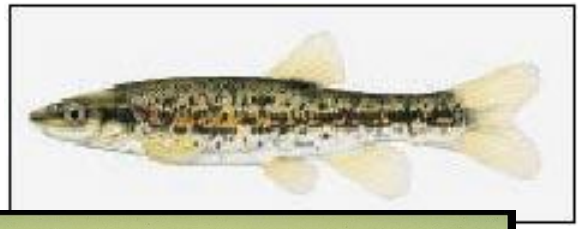
生态系统结构和功能发生极端的变化；分类组成上发生大规模的变化；正常密度发生极端转换.

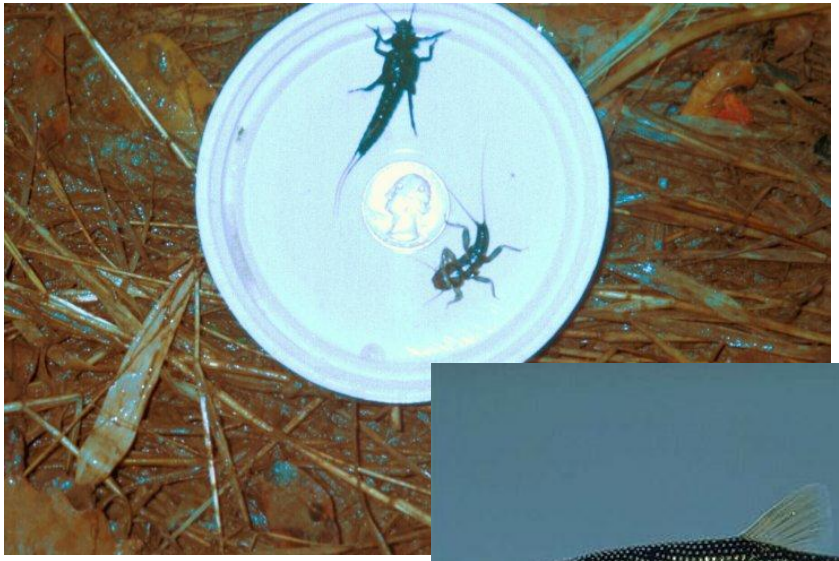


水流域，生境，流动型态 和水化学如自然发生.

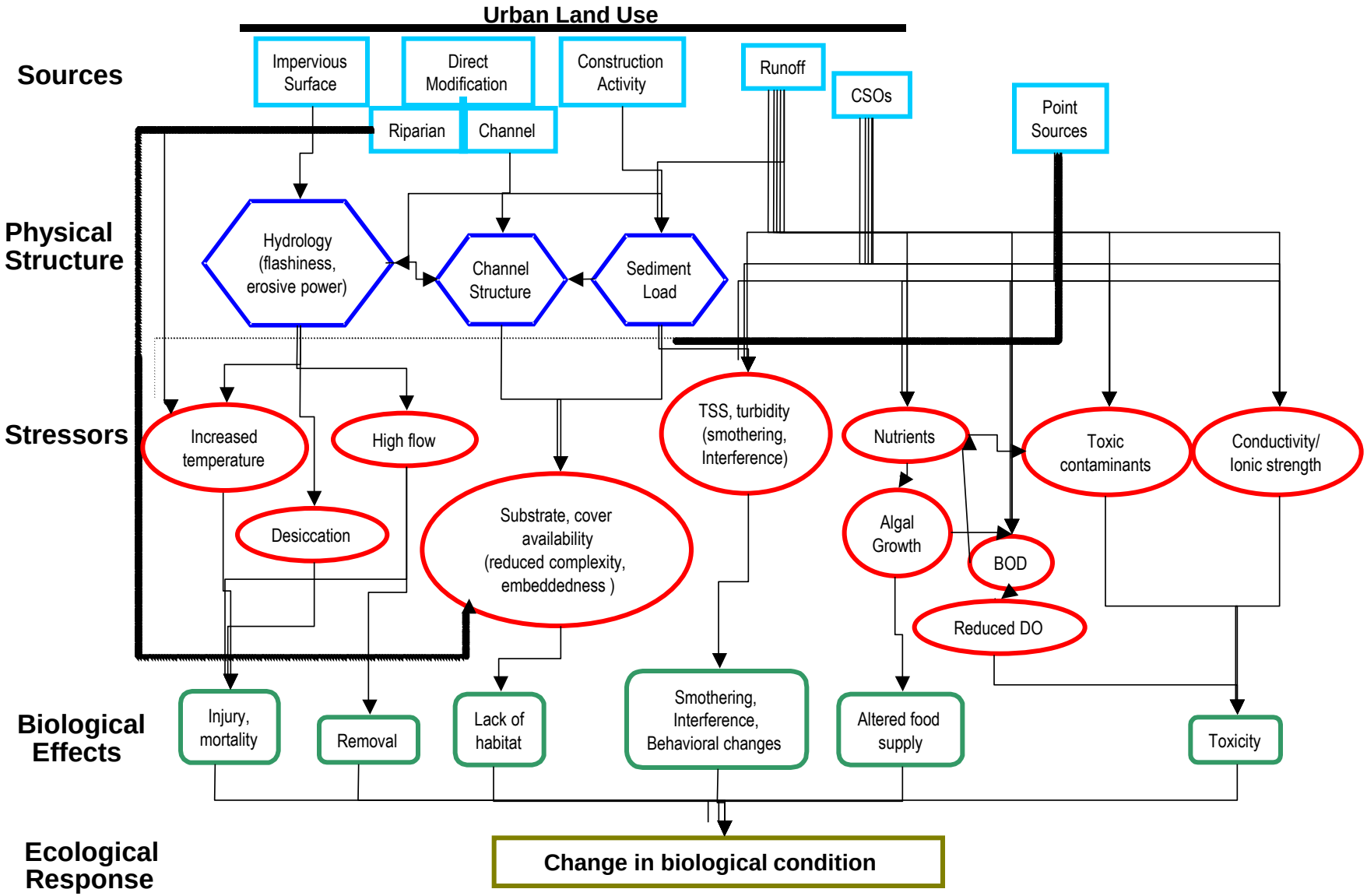
化学，生境，和/或 流动型态从自然状态下严重的扭转.

If biota are unhappy, it's up to us to figure out what is making them unhappy

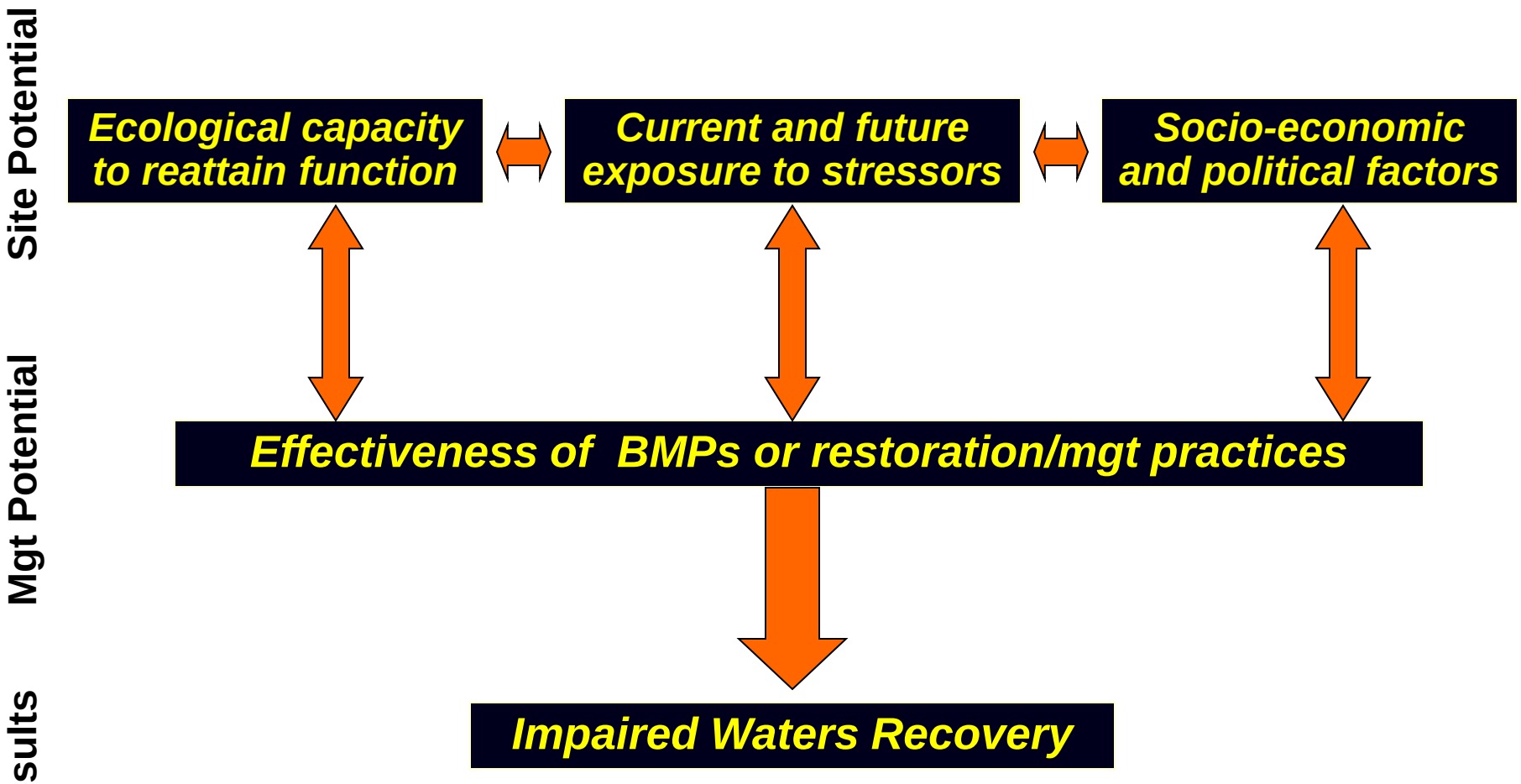




Urbanization -Conceptual Model



The Elements of Recovery Potential



What might ecological recovery potential mean to water agency programs?

- **opportunity to restore higher environmental quality or protect what's not yet lost**
- **create/maintain greater ecological goods and services**
- **seek the optimum mix of management actions that are feasible and affordable**

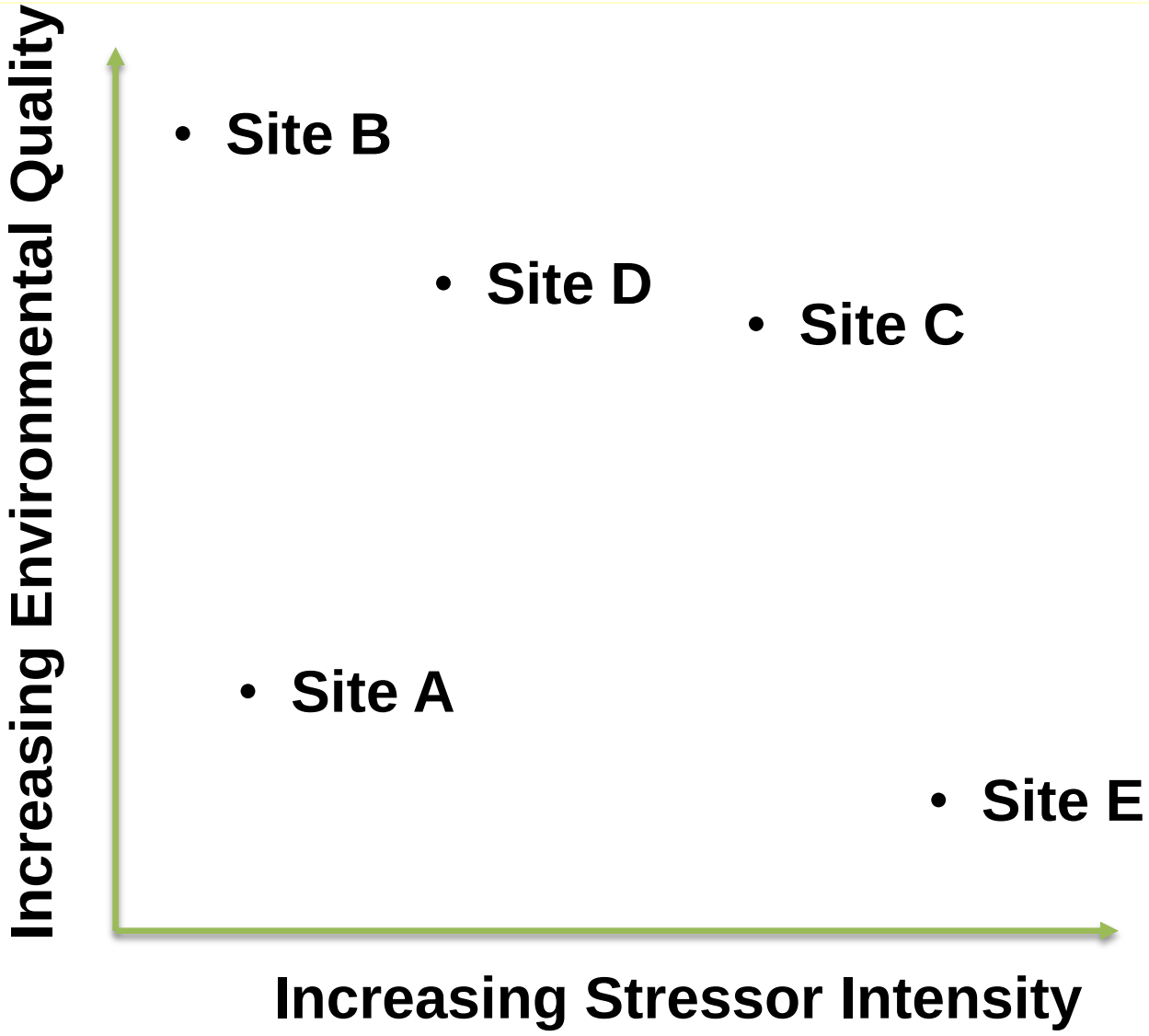
Multiple factors come into play as restoration and protection are considered:

*** 12 highlighted factors --**

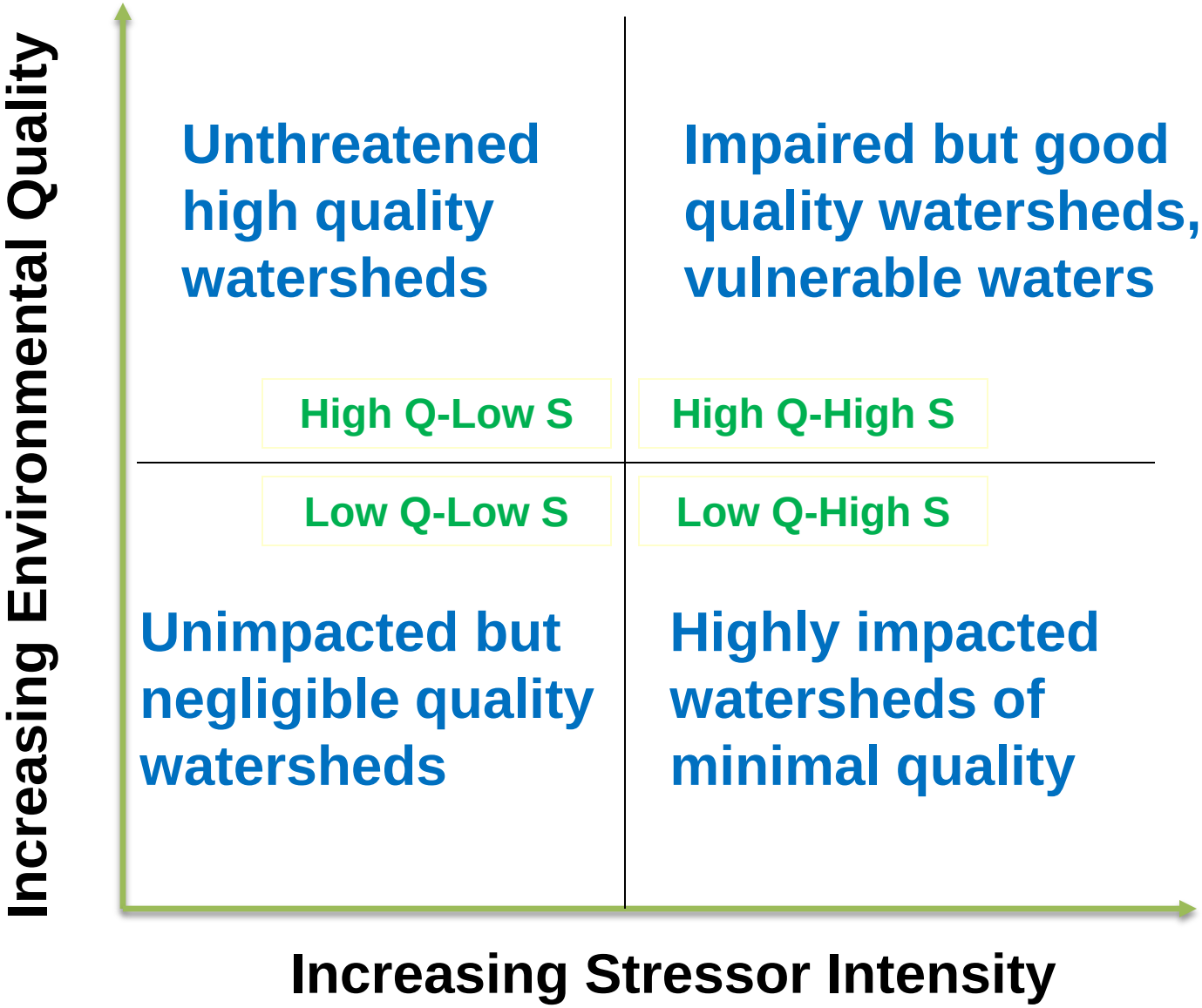
Public health	**Communication**
Demographics	**Local identity**
Education	**Economic conditions**
Governance	**Property/land use**
Recreation	***Natural landscapes***
Boundaries	***Ecology***

In Effective Stakeholder Involvement, You Need Patience

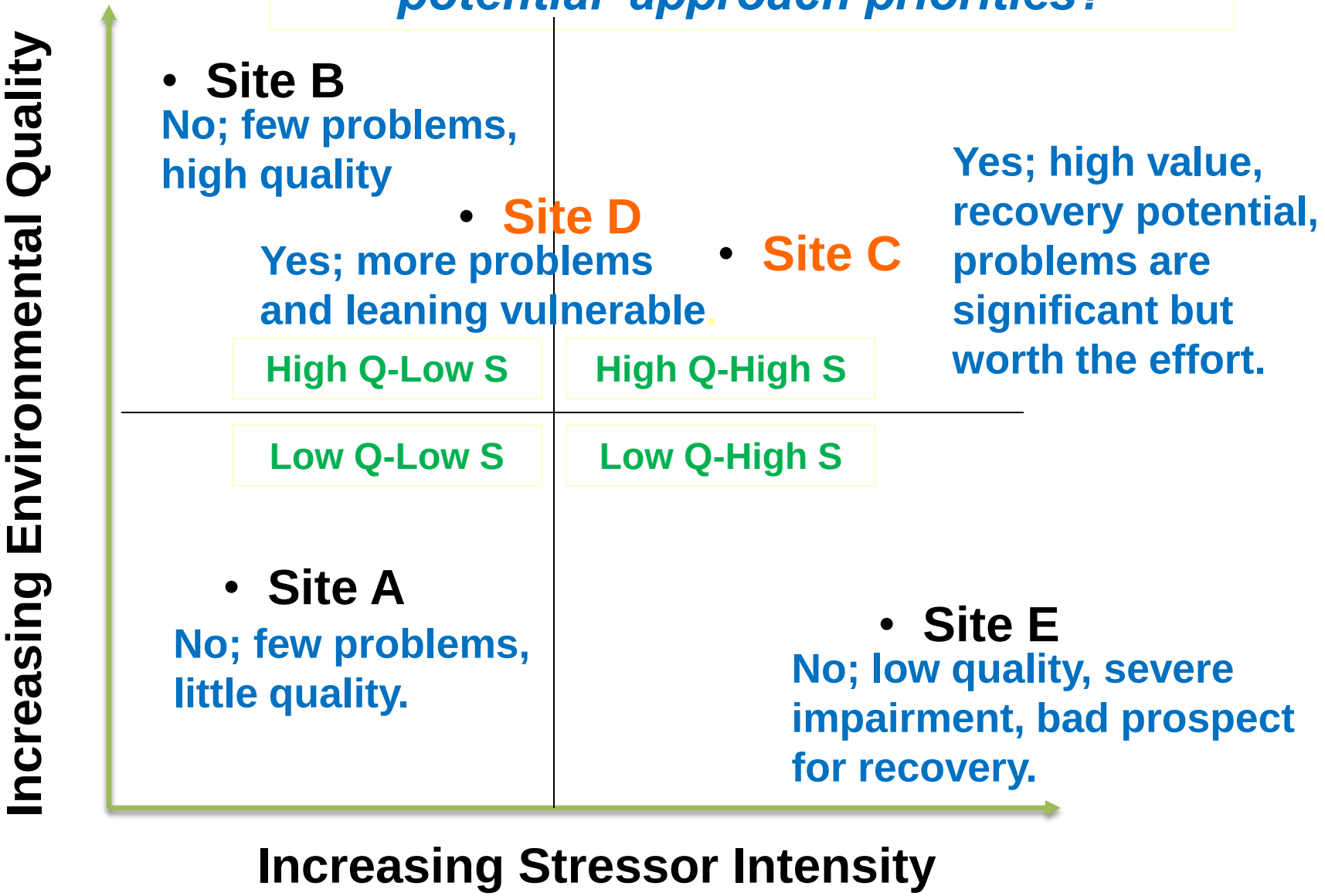
Concepts of environmental quality and stressor intensity are important to priority-setting and recovery potential



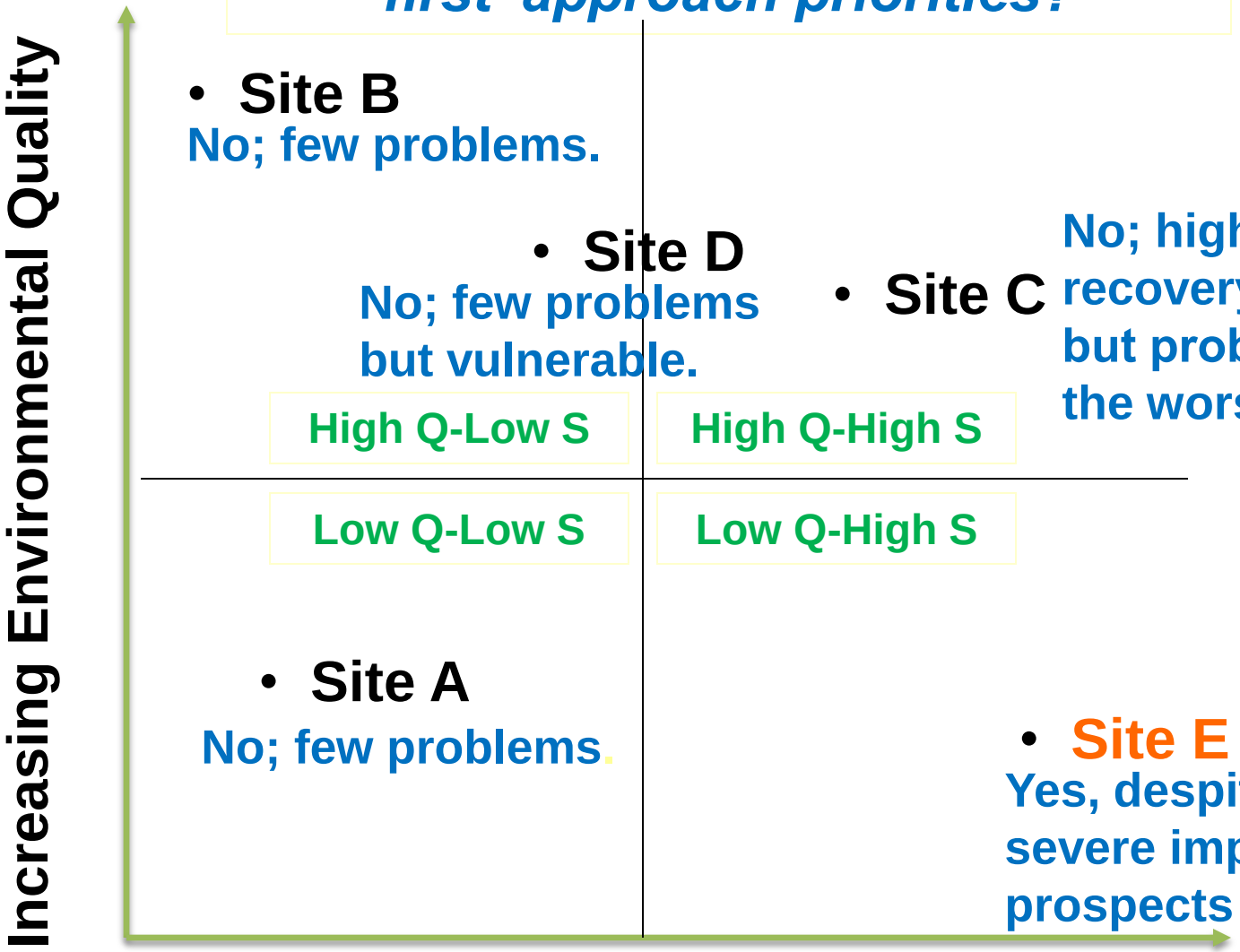
Watershed examples sorted by Stressors X Quality



Which sites might reflect 'recovery potential' approach priorities?



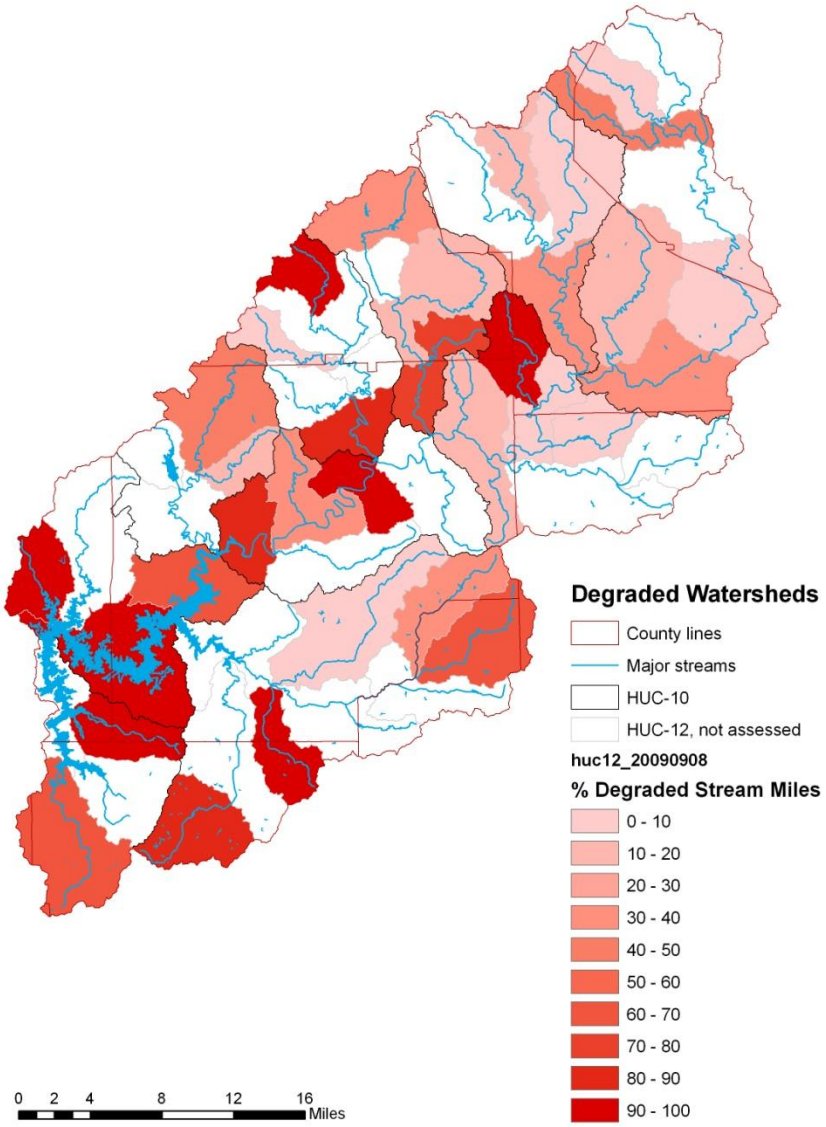
Which sites might reflect 'worst first' approach priorities?



Biological monitoring and assessment as a measure of recovery

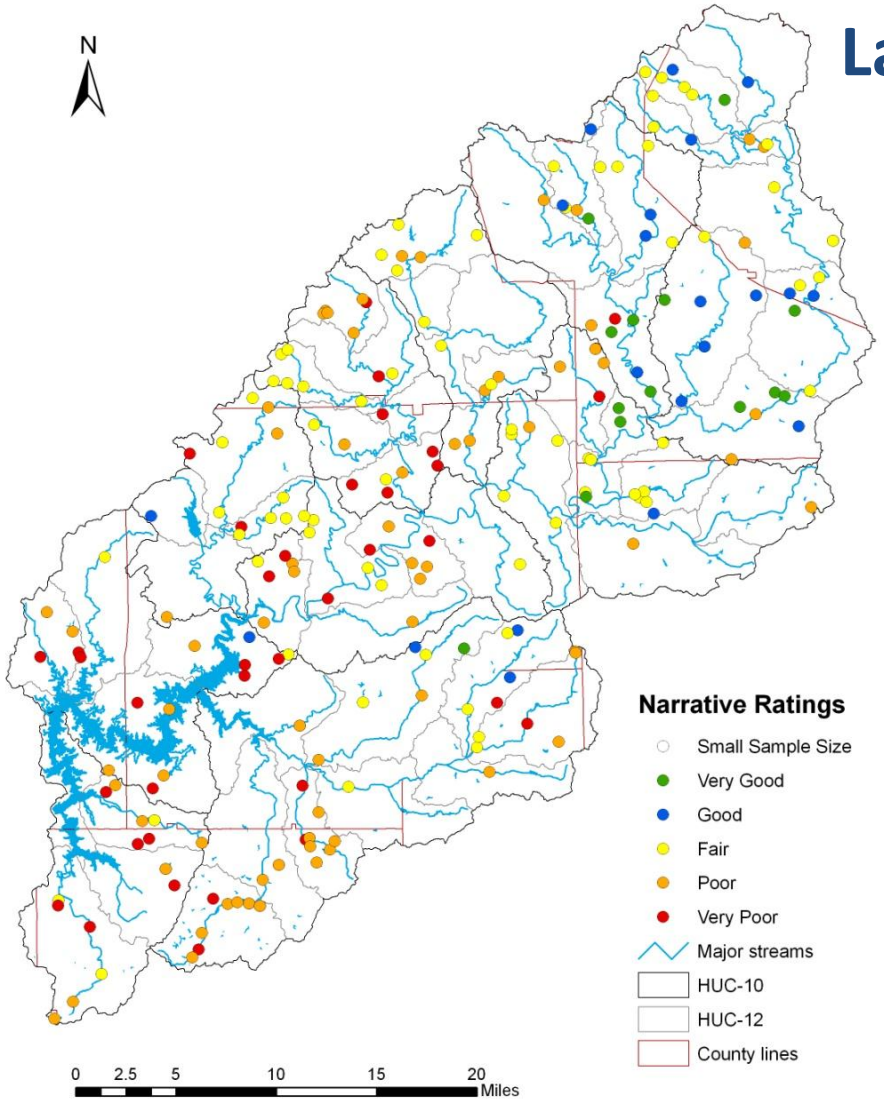
- Phase 1 of bioassessment - Problem identification
- Implement correction *(Restoration, remediation, engineering)*
- Phase 2 of bioassessment – Evaluate effectiveness (ecological recovery)

Lake Allatoona/Upper Etowah River Watershed; Georgia

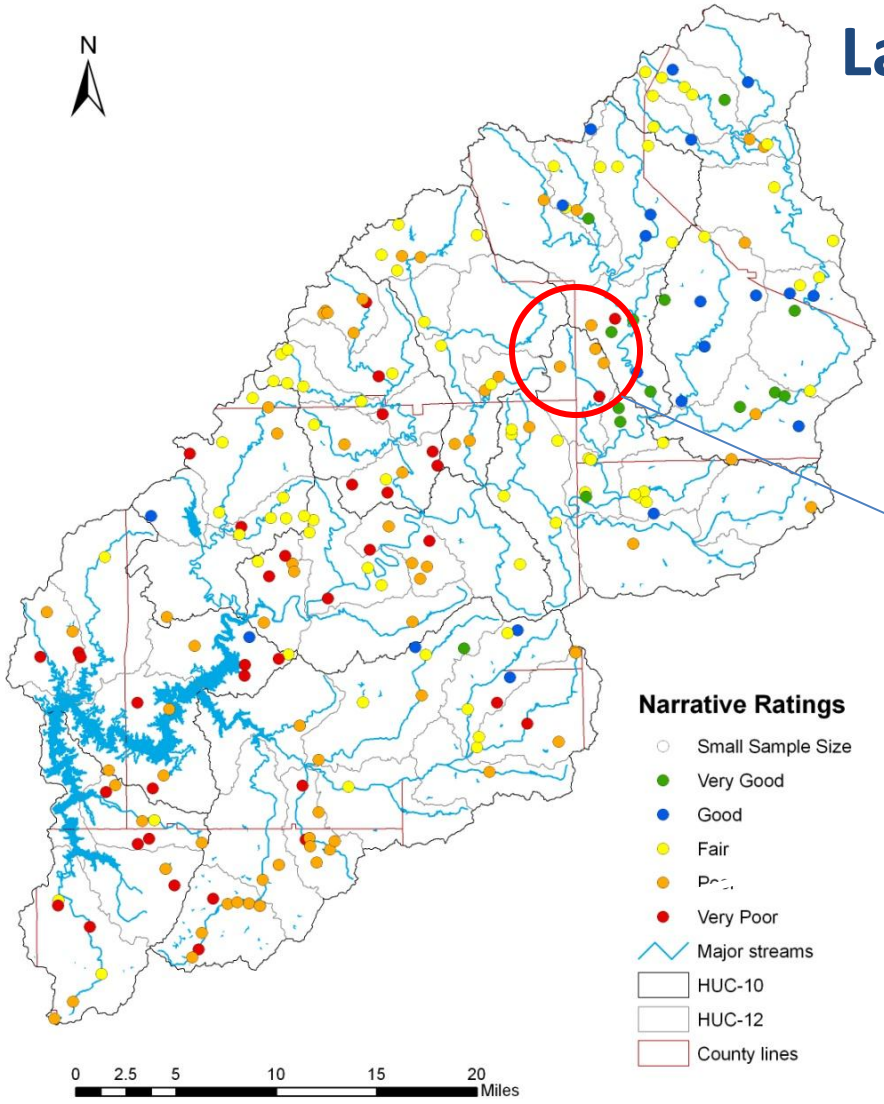


- 1612 total stream channel miles
- Through 2008 (Year 4): 211 sites sampled
- Basin is 65% assessed (1,047 mi.)
- 42.2% biologically degraded (442 mi.)

Lake Allatoona/Upper Etowah River Watershed; Georgia



Lake Allatoona/Upper Etowah River Watershed; Georgia



Example

- Yellow Creek HUC12 subwatershed
- 27.9 stream miles of biological degradation

Yellow Creek subwatershed

- Stressors (*stressor sources*)
  - Physical habitat degradation (*watershed and riparian de-vegetation, some logging and other agricultural activities*)
  - Nutrients (*chicken houses <1.5 miles from each location*)
- "Fixes" (=stressor reduction activities)
  - BMPs, re-vegetation, nutrient management restrictions, bank stabilization, etc.

Yellow Creek subwatershed (monitoring)

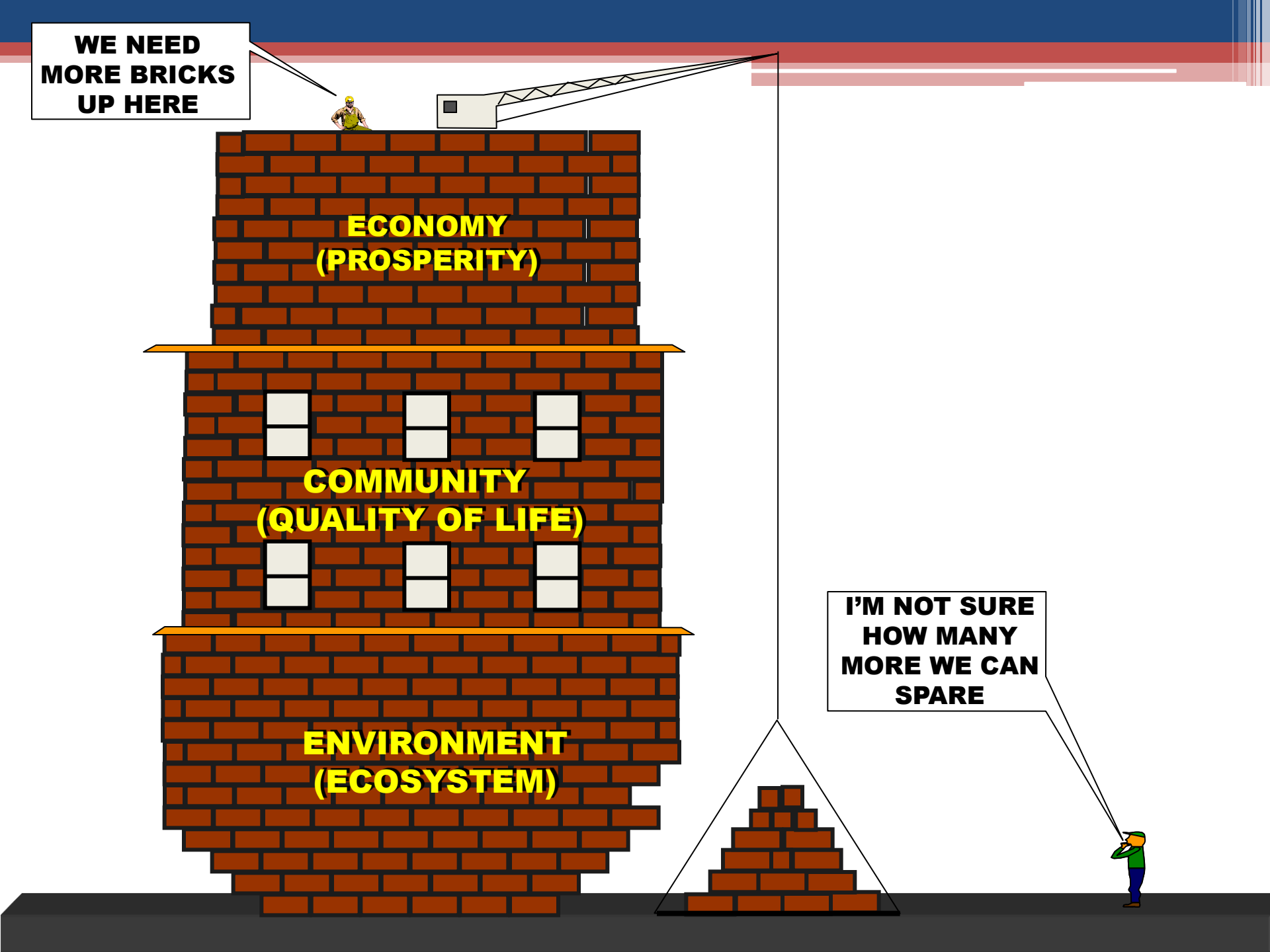
- A) Short-term effectiveness: success in stressor reduction
  - Monitor ***stressors*** that a particular BMP or "fix" was intended to control
- B) Long-term effectiveness: success in ecological recovery (long-term)
  - Requires routine ***biomonitoring*** of/for response indicator

Yellow Creek subwatershed (evaluating restoration success)

- A) Short-term effectiveness
  - Improved bank stability and instream physical complexity, decreased pct fines, elevated geomorphic stability, reduction in nutrients
- B) Long-term effectiveness: success in ecological restoration
  - Reduction of number or pct of biologically-degraded stream miles
  - e. g., over 5-year period, reduced from 27.9 to 14 miles degraded

Take home message(s)

- Environmental and watershed management, done correctly, consists of
  - Restoration (eliminating stressors), and
  - Protection (preventing stressors)
- Do everything you can to ensure defensibility of decisions. That means
  - Biomonitoring for effectiveness of restoration, and
  - Using ecological indicators useful for communicating success
- Restoration is not restoration unless biology responds positively ***(Recovery)***


WE NEED MORE BRICKS UP HERE
ECONOMY (PROSPERITY)
COMMUNITY (QUALITY OF LIFE)
ENVIRONMENT (ECOSYSTEM)
I'M NOT SURE HOW MANY MORE WE CAN SPARE

Thank you

Questions?